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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Hiroji AGA et al.

Group Art Unit: 2823

Application No.: 09/857,803

Examiner: M. Estrada

Filed: June 11, 2001

Docket No.: 109725

For: METHOD FOR PRODUCING SOI WAFER AND SOI WAFER

REQUEST FOR RECONSIDERATION

Director of the U.S. Patent and Trademark Office
Washington, D.C. 20231

Sir:

In reply to the August 28, 2002, Office Action, reconsideration of the rejection is respectfully requested in light of the following remarks.

Claims 1-9 are pending herein.

I. Rejections under §103

A. Yamamoto in view of Takada

Claims 1 and 2 are rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Yamamoto (JP 10-275905) in view of Takada et al. (JP 10-335616). Applicants respectfully traverse this rejection.

1. There is no motivation to combine Yamamoto and Takada

The method for producing an SOI wafer, as set forth in claim 1, clearly specifies that after the delamination step, the wafer having an SOI layer is subjected to a "two-stage heat treatment in an atmosphere containing hydrogen or argon utilizing a rapid heating/rapid cooling apparatus and a batch processing type furnace." Thus, Applicants submit that the language of the claims clearly indicates that the claimed method involves a two-stage heat treatment; One stage in an RTA apparatus and a second stage in a batch processing type furnace in an atmosphere containing hydrogen or argon. Applicants respectfully submit that

neither of the cited references, either alone or in combination with each other, teaches or suggests a two-stage (two-type) heat treatment process as claimed.

The Office Action cites Yamamoto, which teaches annealing an SOI wafer in a hydrogen atmosphere to planarize the delaminated surface in an RTA apparatus. However the Office Action admits that Yamamoto fails to teach or suggest cooling the wafer followed by a subsequent heat treatment in a batch processing type furnace. To cure this deficiency in the teachings of Yamamoto, the Office Action cites Takada.

Takada teaches the thermal treatment of an SOI layer under a near vacuum (1×10^{-6} to 1×10^{-11} Torr) at a temperature of 900 to 1200°C to flatten the surface layer of an SOI wafer. Takada indicates at column 4, lines 43-47, that the near vacuum conditions are required in order to release hydrogen ions, which were implanted into the semiconductor substrate before delamination, from the delaminated surface and thereby reduce the surface roughness of the surface layer. In particular, Takada teaches that after a delamination thermal treatment for 0-10 minutes, the delaminated laminate is subjected to a thermal treatment for 30-120 minutes to planarize the laminated surface under the near vacuum (see Takada, Abstract; FIGS. 2 and 3).

The Office Action asserts that in view of the individual teachings of the cited references, it would have been obvious to one of ordinary skill in the art to combine the teachings of Yamamoto with Takada to derive a two-stage heat treatment process as claimed. However, the Office Action has failed to provide any evidence to support that one of ordinary skill in the art would have been motivated to combine the teachings of the cited references as asserted.

Neither reference teaches or suggests that it would be desirable or advantageous to subject an SOI wafer to an additional heat treatment step. Although both references teach a heat treatment to planarize a laminated surface, each reference teaches the use of a different apparatus in which the heat treatment is carried out. Thus, the cited references only teach or

suggest a one-stage heat treatment. Neither reference teaches or suggests that an additional or subsequent heat treatment in the complementary apparatus would be desirable or advantageous.

In fact, each of Yamamoto and Takada appear to be directed to alternative methods for carrying out the same heat treatment process. Neither reference teaches or suggests that its disclosed process is deficient in any way, such that the disclosed process should be supplemented by a second heat treatment process. In fact, one of ordinary skill in the art looking at the disclosures of Yamamoto and Takada would not have been motivated to combine their separate teachings into a single, two-step process. Instead, one of ordinary skill in the art would only have been motivated to use either the process of Yamamoto or the process of Takada, since both are disclosed to be suitable and effective for their intended purpose.

No motivation for combining the references has been demonstrated by the Office Action, either in the references themselves or the art in general. The combination of Yamamoto and Takada is thus improper.

2. The rejection is based on impermissible hindsight reasoning

Clearly, the only motivation for combining the cited references comes from a hindsight reconstruction of the claimed invention. The Office Action has based the rejection solely on picking and choosing the instant claim limitations from two unrelated references.

It has clearly been held that the reason, suggestion or motivation for combining the references "can not come from the applicant's invention itself." In re Oetiker, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). That is, the motivation for combining the references can not be a product of hindsight reconstruction of the claimed invention based on applicant's own disclosure. Such a hindsight reconstruction has clearly been made in the present Office Action.

The Office Action asserts that the claimed invention would have been obvious based on a hindsight selection of the claimed limitations, as evidenced by the teachings of the cited

references, neither of which would suggest to one skilled in the art that the teachings could or should be combined and then further modified to provide the claimed invention. Such a combination is improper because the references, viewed by themselves and not in retrospect, must suggest the combination asserted by the Office Action. In re Shaffer, 229 F.2d 476, 108 USPQ 326 (C.C.P.A. 1956); In re Stoll, 523 F.2d 1392, 187 USPQ 481 (C.C.P.A. 1975). Here the references do not provide any motivation for combining the separately disclosed heat treatment processes. The only motivation for combining the cited references in the manner asserted in the Office Action derives from the disclosure of the present application, which is clearly improper.

3. The rejection ignores the context of the teachings of Takada

In addition, it is impermissible within the framework of 35 U.S.C. §103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation that the reference fairly suggests to one of ordinary skill in the art. In re Wesslau, 147 USPQ 391, 393 (CCPA 1965). In the Office Action, Takada is relied upon only for its showing of a heat treatment in a batch type furnace. However, the process taught by Takada is performed under conditions that are distinct from those in the process described by Yamamoto.

In particular, Yamamoto teaches a heat treatment process under a hydrogen atmosphere. However, Takada performs the heat treatment under what is essentially a vacuum (e.g., 1×10^{-6} to 1×10^{-11} Torr). Takada teaches that the near vacuum pressure of the atmosphere is necessary in order to release hydrogen ions from the delaminated surface through the heat treatment process. Thus, in order to allow the release of the hydrogen from the delaminated surface as in the process of Takada, one of ordinary skill in the art would not have been motivated to use a hydrogen atmosphere as in the process of Yamamoto. However, the Office Action nowhere addresses these contradictory teachings of the references, and does

not reconcile how a combination of the references would continue to provide an operable process consistent with the teachings of the references.

In addition, the assertion of the Office Action that the presence of trace amounts of hydrogen and argon in the near vacuum atmosphere taught by Takada is the equivalent of a hydrogen or argon atmosphere is a gross misinterpretation of the teachings of Takada. To interpret the teachings of Takada in this manner would render the positive recitation of an atmosphere comprising a particular gas useless. Clearly, in order to combine the teachings of Yamamoto and Takada, it would have required one of ordinary skill in the art to ignore the proper context of the teachings of Takada. The rejection is clearly based on improper picking and choosing of a single process step in a manner that could only be done if one were trying to reconstruct the claimed invention in hindsight, following the disclosure of Applicants' invention.

Even if the heat treatments of both Yamamoto and Takada are combined, the resulting combination would not be the two stage heat treatment utilizing an RTA apparatus and batch processing-type apparatus as claimed. As discussed above, Yamamoto essentially performs a heat treatment in a hydrogen atmosphere, but Takada essentially performs a heat treatment under a near vacuum atmosphere. Therefore, even if RTA is performed in a hydrogen atmosphere based on the teachings of Yamamoto followed by a heat treatment as taught by Takada, the combined heat treatment does not teach or suggest the claimed method in which both heat treatment steps are performed under an atmosphere containing hydrogen or argon. Takada clearly teaches that hydrogen ions are released from a delaminated surface by the heat treatment in a high vacuum atmosphere. It should be understood that the release of the hydrogen ions from the delaminated surface through the heat treatment requires the near vacuum atmosphere. Thus, one of ordinary skill in the art would not have been motivated to perform the heat treatment step taught by Takada in an atmosphere containing hydrogen.

4. **The claimed process yields results that cannot be obtained by the methods taught by Yamamoto and Takada**

Furthermore, neither reference teaches or suggests that the surface roughness of both long and short periods may be improved by subjecting the SOI wafers to a two-stage heat treatment process. As stated in the specification, at page 8, lines 1-11, "surface crystalllinity is restored and the surface roughness of short periods is improved in the heat treatment by the rapid heating/rapid cooling apparatus, and the surface roughness of long periods can be improved by the heat treatment utilizing the batch processing type furnace." Thus, the treatment of the SOI wafers under different conditions in two different apparatus yields results that would not be attainable using the methods described in the cited references because the references only teach the use of individual, alternative heat treatment processes. As such, these results would have been unexpected over the teachings of Yamamoto and Takada.

5. **Conclusion**

For at least these reasons, claims 1-2 would not have been obvious over the cited references. Reconsideration and withdrawal of the rejection are respectfully requested.

B. Yamamoto and Takada, further in view of Adachi and Wolf

Claims 3-5 are rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Yamamoto and Takada, further in view of Adachi et al. (US 6,074,479) and Wolf et al., "Silicon Processing for the VL51 Era", Vol. 1 (1986) Lattice Press, pp. 23-25. Applicants respectfully traverse this rejection.

Because the rejection relies on the combination of Yamamoto and Takada as the primary references, Applicants respectfully submit that the rejection should be withdrawn. Even if one of ordinary skill in the art were to combine the teachings of Adachi and Wolf with those of Yamamoto and Takada, the citation of Adachi and Wolf fails to cure the deficiencies identified in the teachings of Yamamoto and Takada for the reasons discussed above.

The main feature of the claimed method for producing an SOI wafer according to claim 3 of the present application is that "an FZ wafer, an epitaxial wafer or a CZ wafer of which COPs at least on surface are reduced is used as the bond wafer, and the wafer having an SOI layer is subjected to a heat treatment under an atmosphere containing hydrogen or argon in a batch processing type furnace after the delamination step." Because a CZ wafer or the like in which COPs at least on its surface are reduced is used as the bond wafer and the wafer is subjected to a heat treatment under an atmosphere containing hydrogen or argon in a batch processing type furnace after the delamination step, it avoids the problem whereby a buried oxide layer is etched due to COPs (see specification, page 6, line 24-page 7, line 3). Thus, the formation of pits resulting from the etching of the buried oxide layer through the COPs and the SOI layer during the hydrogen annealing treatment is avoided. This permits a heat treatment at a high temperature for a long period of time in a batch processing type furnace.

Adachi teaches that wafers are annealed in a furnace to eliminate grown in defects, which give rise to surface and internal crystal originated particles (COP). However, contrary to the assertion of the Office Action, one of ordinary skill in the art would not have been motivated to combine the teachings of Adachi with those of Yamamoto and Takada. None of the references teaches or suggests that a CZ wafer in which COPs on the surface are reduced should be used as a bond wafer because none of the references recognize that a buried oxide layer is etched through COP by hydrogen gas. Thus, one of ordinary skill in the art would not have been motivated to combine the teachings of Adachi with the cited primary references.

With respect to claim 4, the main feature of the claimed feature is that "a CZ wafer produced from a single crystal ingot of which COPs are reduced for the whole crystal is used as the bond wafer." By using a CZ wafer produced from a single crystal ingot of which COPs are reduced for the whole crystal as a bond wafer (see specification, page 10, line 24-

page 11, line 11), the occurrence of bonding failures can be significantly reduced. This method can be applied to a wafer having a large diameter and also does not limit the stock removal of the delaminated plane for polishing when the delaminated wafer is recycled as a bond wafer.

In addition, claim 4 specifies that "COPs are reduced for the whole crystal" in the ingot used as the bond wafer. The use of a CZ wafer produced from a single crystal ingot in which COPs are reduced for the whole wafer as a bond wafer is distinct from the use of a wafer in which COPs are eliminated by annealing, as COPs in the wafers taught by Adachi are removed only from the surface of the wafer. Thus, the bond wafer of claim 4 is structurally distinct from the bond wafer taught in Adachi.

Wolf teaches that a CZ wafer can be obtained by slicing a single crystal ingot. However, Wolf fails to provide and teachings or motivation that would cure the deficiencies identified in the teachings of Yamamoto, Takada and/or Adachi. Thus, one of ordinary skill in the art would not have been able to derive the claimed invention based on the teachings of the cited references.

For at least these reasons, claims 3-5 would not have been obvious over the cited references. Reconsideration and withdrawal of the rejections are respectfully requested.

II. Conclusion

In view of the foregoing remarks, Applicants submit that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the pending claims are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number set forth below.

Respectfully submitted,

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